ABSTRACT

Rotary dryer (RD) is equipment that has been widely used in industrial drying process for not too fragile and heat sensitive materials.

The aim of this research was to determine drying rate of ammonium sulfate (ZA) and analyze theoretically the effects of solid feedrate, rate and inlet temperature of air dryer on outlet solid moisture content by considering solid axial dispersion.

The research was carried out in several steps. First, solid drying rate was determined theoretically using isothermal diffusion model in spherical solid particle. Then, the predicted drying rate was used to simulate the rotary dryer performance by assuming plugflow pattern with axial dispersion for solid flow (Plug Flow With Axial Dispersion or PFAD model). The mathematical model development resulted a system of non linear ordinary differential equations that describing heat and mass transfer phenomena in RD. Then, the differential equations were solved using Finite Difference Method with Crank-Nicholson Scheme. The non linear algebraic equations generated by this method were solved using Newton-Raphson Method. The simulation program was developed under the environment of Matlab. Resulted program simulation was validated by
operational data of commercial rotary dryer and finally the program was used to study theoretically the effect of several process variables on the dryer performance.

Empirical correlation drying rate (R) obtained from drying simulation was $R_w = 1.046 \times 10^{-15} \sqrt{v}^{0.7826} H^{-0.0196} T^{5.005}$. This equation was used in RD model to predict drying rate of ZA. Validation of simulation program showed that average error of evaporated moisture content calculation was 4.51% for PFDA Model.

The simulation result showed the increasing of ZA moisture content from 0.112% to 0.119% with increasing ZA feedrate from 25 ton/hr to 43 ton/hr. The decreasing ZA moisture content from 0.112% to 0.042% with increasing air dryer rate from 7000 m$^3$/hr to 11000 m$^3$/hr. The decreasing ZA moisture content from 0.595% to 0.112% with increasing inlet dryer temperature from 60°C to 110°C.

**Keywords**: Rotary dryer, ammonium sulfate, theoretically drying rate, plugflow with axial dispersion